SEA LEVEL RISE VULNERABILITY ASSESSMENT

A summary of Port of San Francisco assets, projected inundation maps + adaptation strategies

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CONTENTS

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ABBREVIATIONS

AB	Assembly Bill
BayCAN	Bay Area Climate Adaptation Network
BCDC	Bay Conservation and Development Commission
CAP103	Continuing Authorities Program Section 103
CCSF	City and County of San Francisco
CPC	Capital Planning Committee
DEM	Digital Elevation Model
FEMA	Federal Emergency Management Agency
FIRMs	FEMA Flood Insurance Rate Maps
GIS	Geographic Information System
LHMP	Local Hazard Mitigation Plan
LIDAR	Light Detection and Ranging
MHHW	Mean Higher High Water
MHRA	Multi-hazard Risk Assessment
MTA	San Francisco Municipal Transportation Agency
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
OPC	Oceanic Protection Council
PG&E	Pacific Gas and Electric Company
Port	Port of San Francisco
SFPUC	San Francisco Public Utilities Commission
SFWFRS	San Francisco Waterfront Flood Resilience Study
SLR	Sea Level Rise
SLRVCA	Sea Level Rise Consequence and Vulnerability Assessment
USACE	United States Army Corps of Engineers

1 INTRODUCTION

1.1 AB 691 Background

The State of California passed Assembly Bill 691 (AB 691) in October 2013, requiring trustees of public lands to prepare an assessment of facilities and assets vulnerable to sea level rise (SLR), comprised of:

- An assessment of SLR impacts to facilities and assets considering storms and extreme events, changing shorelines and trends in relative local sea level
- Development of 2030, 2050, and 2100 impact maps of the 100-year storm event
- An estimate of financial costs of SLR for repair and replacement of impacted resources and facilities and the non-market costs of recreation and ecosystem services
- A description of how to protect and preserve resources and structures impacted by SLR and the potential benefits of the strategies
- An estimate of cost to protect or mitigate identified impacts.

1.2 The Port of San Francisco + State of California Granted Lands

The City and County of San Francisco, through the San Francisco Port Commission, was granted sovereign tide and submerged lands in trust in 1968 through legislation referred to as the Burton Act. Since the enactment of the Burton Act, the Legislature has amended the Port's statutory trust grant through over 20 statutes. Many of these amendments were enacted to facilitate the improvement of the infrastructure and historic structures on trust lands along the San Francisco waterfront as the Port's role and purpose has evolved over time.

Today, the Port manages the waterfront as the gateway to a world-class City, and advances environmentally and financially sustainable maritime, recreational, and economic opportunities to serve the City, the Bay Area, and California.

1.3 Summary of Vulnerability Assessment + Adaptation Efforts

The Port has commissioned directly and participated in multiple, multi-agency SLR vulnerability assessments and adaptation plans to identify the risk and adaptation strategies associated with SLR. This section summarizes these efforts, most of which are actively ongoing, and Appendix A provides a comprehensive list of relevant documents.

1.3.1 City of San Francisco Sea Level Rise Action Plan (2016)

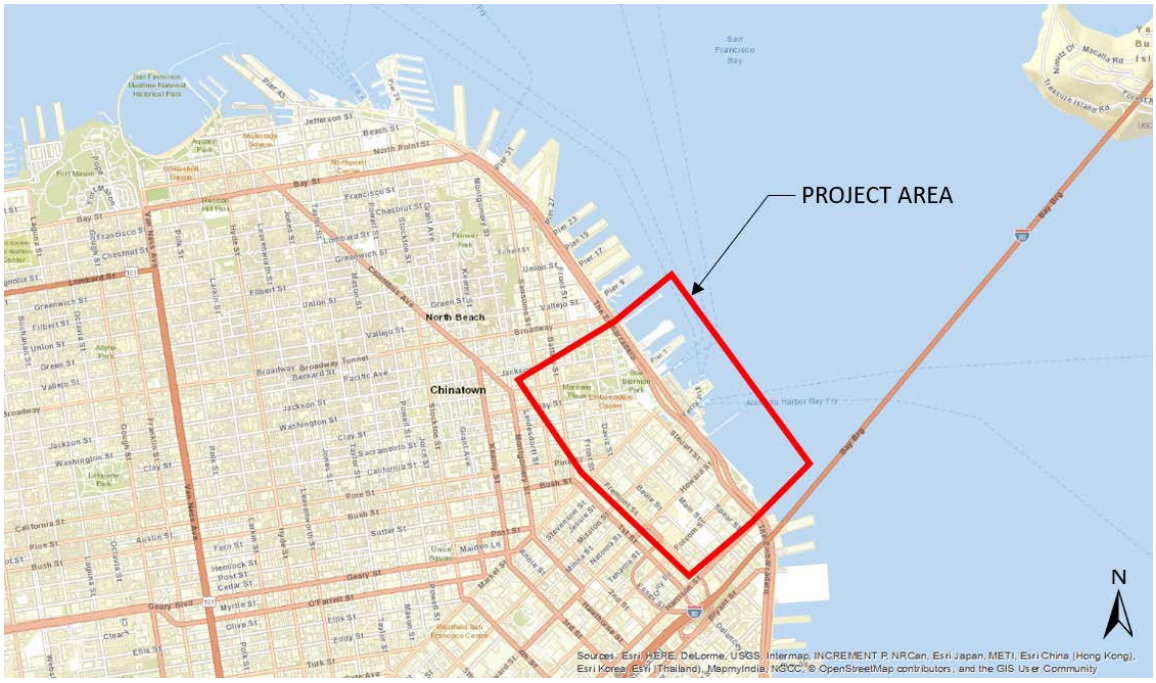
The Port has been a major contributor and participant in the development of the San Francisco *Sea Level Rise Action Plan* released in March 2016. This San Francisco *Sea Level Rise Action Plan* aims to:

- Establish an overarching vision, goals, and a set of guiding principles for SLR planning;
- Summarize current climate science, relevant policies and regulations, and vulnerability and risk assessments conducted to date;
- Identify data gaps and establish a framework for further assessment, adaptation planning, and implementation;
- Provide the foundation and guidance to develop a Citywide SLR Adaptation Plan and a more resilient San Francisco (see Section 1.3.4.6).

1.3.2 CAP 103 Study, USACE (2017, suspended)

In 2017 the Port and USACE began a *Continuing Authorities Program Section 103* (CAP 103) feasibility study of coastal storm risk management along a half-mile stretch of the San Francisco waterfront. The project area generally included the waterfront area extending from Pier 22.5 at the south, to Pier 7 at the north as shown in Figure 1-1. The CAP 103 Study was replaced by the San Francisco Waterfront Flood Resilience Study described in Section 1.3.4.2.

Figure 1-1. CAP 103 Project Area



Source: *San Francisco Waterfront Continuing Authorities Program Section 103, Coastal Storm Risk Management Project – Measure Fact Sheets (Draft)*, Port/Arcadis/CH2M (2018)

1.3.3 Sea Level Rise Vulnerability & Consequences Assessment, CCSF (ongoing)

The City of San Francisco *Sea Level Rise Vulnerability & Consequences Assessment* (SLRVCA), provides detailed actions required to adapt to the expected SLR and flooding outlined in the City's *Sea Level Rise Action Plan* from 2016. The SLRVCA focuses on publicly owned infrastructure categorized as Mobility, Water, Wastewater, Public Safety, Open Space, and Port that falls within the identified SLR Vulnerability Zone. Impacts to people, the economy, and the environment are analyzed on a neighborhood scale, with emphasis placed on the additional strain experienced by vulnerable populations in these locations.

Citywide impacts of concern include combined coastal flooding and heavy rainfall. These impacts are magnified in areas with contaminated soil and are of specific concern in Mission Bay, Isais Creek, Bayview, and Hunters Point. Most of the City's new development is occurring along this southeastern shoreline, and although the phased buildout of these plans actively incorporate designs for SLR that extend far into the future, adaptive measures solely address new development; neighboring facilities or infrastructure are not covered by these adaptation strategies.

Another concern is the loss of public open space situated along the shore. These spaces can be utilized in adaptation strategies; however, the resulting loss of open space must then be accounted for by other means. Impacts to regional transportation networks are a major issue considering the reliance of the City on workers from around the Bay Area. The City's unique geographic location compounds its reliance on other agencies, cities, and counties to work together in planning for the impacts of SLR on these vital pieces of infrastructure at a regional scale.

The SLRVCA outlines planning strategies starting with community engagement, prioritizing vulnerable neighborhoods, and finding solutions that are both ecological and impactful across many scales. These planning strategies will be aligned with existing projects and implemented both immediately and over time. The SLRVCA will be used as a tool and educational resource for City agencies, decision makers, and the general public to be able to make informed decisions about next actions and funding allocation. Preliminary findings of the *SLRVCA* are summarized in Section 3.

1.3.4 The Port of San Francisco Waterfront Resilience Program (ongoing)

The Port of San Francisco manages 7.5 miles of bayside shoreline property. The Port's Waterfront Resilience Program ensures the City of San Francisco's bayside waterfront is protected from hazards including earthquakes, flooding, and SLR due to climate change. The Port's Waterfront Resilience work is an inclusive effort that aligns with many different initiatives. These include:

- The Embarcadero Seawall Program
- USACE/Port San Francisco Waterfront Flood Resiliency Study (SFWFRS)
- Floodproofing the Piers
- Southern Waterfront Seismic Vulnerability Assessment
- Waterfront Resilience Program Communications and Engagement Plan
- Citywide Resilience Coordination
- Ongoing project-specific sea level rise adaptation strategies

The Waterfront Resilience Program has shared the following draft Vision and Principles with the public and is currently receiving comments and input at meetings and online:

VISION:

The Port of San Francisco's Waterfront Resilience Program will create a safe, equitable, sustainable, and inspiring waterfront.

PRINCIPLES:

1. Prioritize life safety and emergency response
2. Advance equity in inclusive engagement, planning, and decision-making
3. Enhance and sustain economic and ecological opportunities
4. Inspire an adaptable waterfront that:
    - Improves the health of the Bay
    - Ensures access to the waterfront and historic places
    - Protects and preserves historic resources
    - Provides opportunities for families, businesses, and neighborhoods to thrive
5. Lead a transparent, innovative, collaborative, and adaptive resilience program

1.3.4.1 The Embarcadero Seawall Program (ongoing)

As part of the Waterfront Resilience Program and the USACE Flood Resiliency Study (see Section 1.3.4.2), the Port of San Francisco is leading the Embarcadero Seawall Program, a Citywide effort to strengthen the Embarcadero Seawall and create a more sustainable and resilient waterfront. Program goals include:

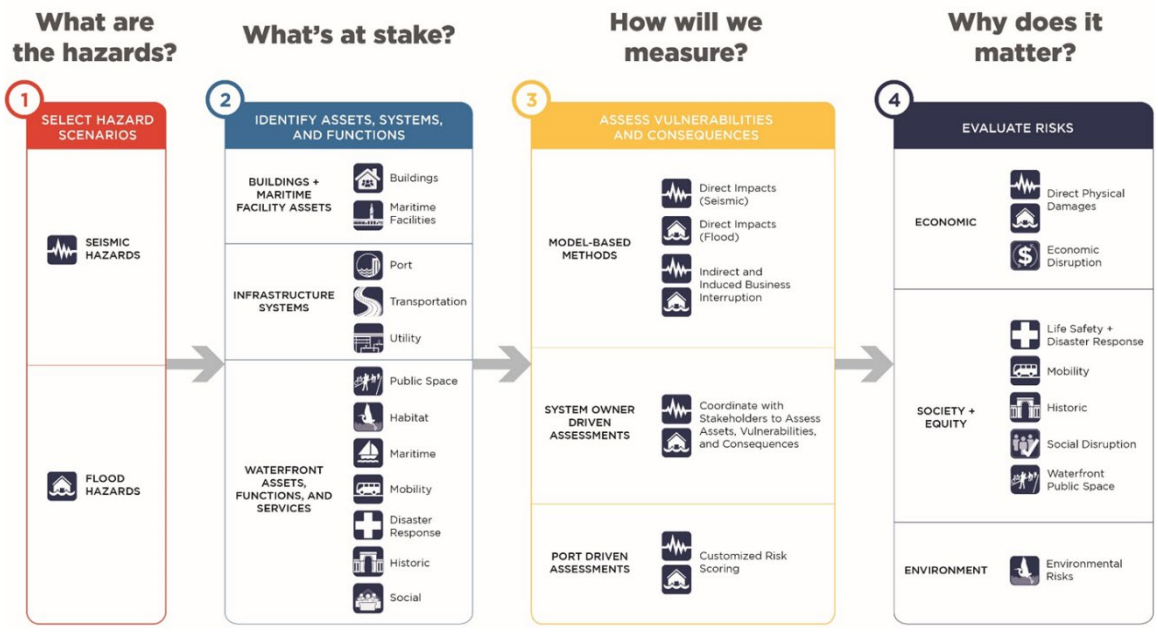
- Act responsibly, transparently, and with accountability
- Reduce earthquake damage
- Improve flood resilience

- Engage the community
- Enhance the City and the Bay
- Preserve historic resources

San Francisco voters approved a $425 million General Obligation Bond for the Program in the November 2018 election. To date, the Port has secured $440 million for urgently needed immediate life safety improvements, and is currently pursuing local, state, federal, and private funding sources to fully fund infrastructure improvements anticipated to cost up to $5 billion.

Immediate seismic and flood protection upgrades are targeted for completion by 2026. The Program is currently in the scoping and assessment phase, which includes program development, planning, community engagement, and a multi-hazard risk assessment (MHRA) that will provide a more refined understanding of the seismic and flood risk, as well as an identification of the vulnerabilities of the assets within the program area. The MHRA is summarized in Figure 1-2 and will be integrated with the Port's "Strengthen, Adapt, and Envision" framework discussed in Section 5.

Figure 1-2. Multi-hazard Risk Assessment Methodology



Source: Waterfront Resilience Program, Port (2019)

1.3.4.2 San Francisco Waterfront Flood Resilience Study, USACE/Port (ongoing)

In June of 2018, the Army Corps of Engineers (USACE) selected the San Francisco Waterfront as one of only six New Start studies nationwide for coastal flood risk. In

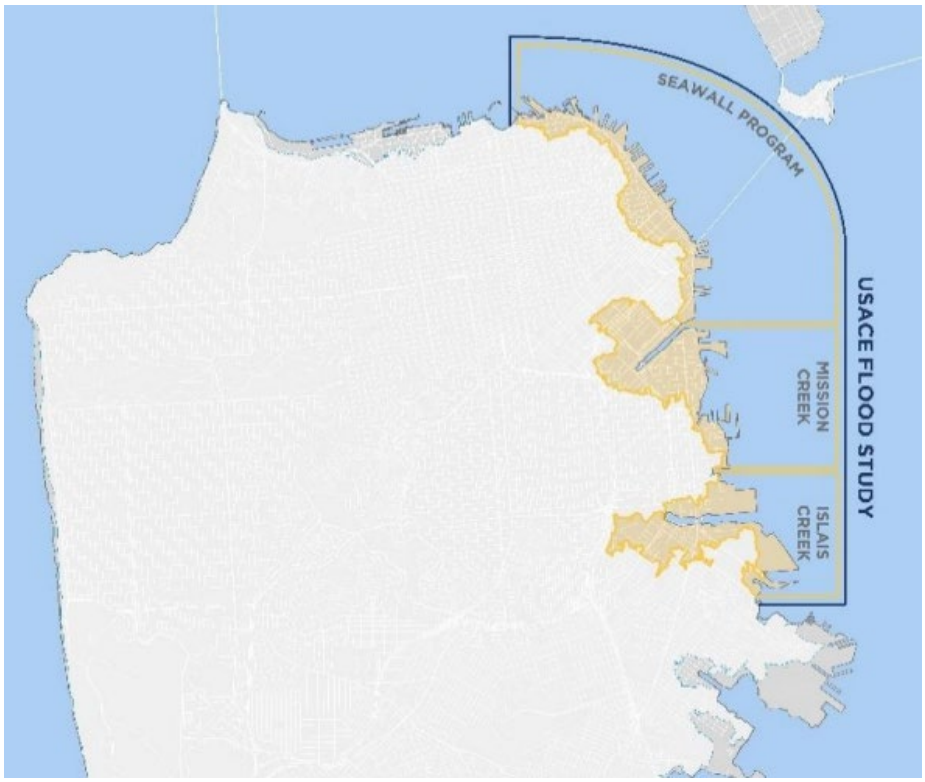
September 2018, the Port of San Francisco signed an agreement to move forward with the project, which was initially named the San Francisco Waterfront Storm Damage Reduction project, and since renamed the San Francisco Waterfront Flood Resilience Study (SFWFRS), with the Port as the selected local sponsor. The SFWFRS project encompasses the waterfront area from Aquatic Park to Heron's Head Park and is focused on assessing the flood risk to the federal interest. The Port had been working with USACE for many years and sought USACE assistance in the Embarcadero Seawall Program to bring federal flood management expertise and resources to the program. The SFWFRS project includes the Embarcadero Seawall Program and extends beyond it to both the north and the south as shown in Figure 1-3.

The purpose of the SFWFRS is to:

1. Determine whether there is a federal interest in reducing the flood risk to the project area by identifying the assets and services at risk and the economic effects of flooding to the federal government.
2. Determine the size of the federal interest, which will inform the amount to invest on a project to reduce the flood risk.
3. Work with and engage a broad range of stakeholders to identify the goals and objectives of a flood risk reduction project.
4. Develop alternatives to both reduce flood risk and meet other identified goals and objectives of the project (e.g. preserve and enhance historic resources, improve Bay and shoreline open spaces and ecology).
5. Identify a tentatively selected plan that is supported by USACE, the Port of San Francisco, the City and County of San Francisco, local and regional communities, agencies and organizations.
6. Advance the preferred alternative that maximizes net benefits (flood risk reduction, recreation, seismic risk reduction, Bay ecology, etc.) to USACE and Congress for funding.

The project is estimated to be a three to five-year study, which began in September 2018. The SFWFRS is currently in the scoping and assessment phase of the work. Inundation maps developed under this ongoing effort will be based on the "USACE-High" SLR projections described in Section 2.1.3.

Figure 1-3. Extent of USACE SFWFRS



Source: Waterfront Resilience Program, Port (2019)

1.3.4.3 Floodproofing the Piers Study (ongoing)

The Floodproofing the Piers Study is intended to develop a range of strategies to reduce the flood risk of the Port's historic finger piers. The purpose of the study is to extend the life of the historic finger piers and to complement the work being conducted in the USACE/Port SFWFRS and the Embarcadero Seawall Program, as well as inform the Port's Historic Piers Rehabilitation Program.

The objective of this technical study is to present information needed to facilitate a meaningful and informed discussion of the future of the Port's pier facilities. This study will not speak to the relative importance of specific pier facilities or to Port policy decisions about which piers will receive investment. It is assumed that the solutions and adaptation methodology followed within this study can be extrapolated to all pier facilities in future efforts. Specific objectives for this study include:

- Compile relevant, existing flood risk data to measure against adaptation strategies.

- Build a suite of flood protection measures ranging from relatively minor additions to existing facilities, to significant interventions requiring major capital investment; including examination of the engineering and cost feasibility of these solutions.
- Utilize a specific subset of piers (19 and 38) to lay out flood risk mitigation strategies based on changing risk profile into the future.

Completion of a final report for the Floodproofing the Piers Study is anticipated in late 2019 or early 2020.

1.3.4.4 Southern Waterfront Seismic Vulnerability Assessment (ongoing)

The Southern Waterfront Seismic Vulnerability Assessment has recently launched, with completion planned in Fall/Winter 2020. The assessment is intended to provide a better understanding of the seismic risks to the Port's facilities and the shoreline between Mission Creek and Heron's Head Park. The effort will inform the USACE/Port SFWFRS assessment and alternatives development for flood reduction measures.

1.3.4.5 Waterfront Resilience Program Communications and Engagement Plan (ongoing)

The Waterfront Resilience Program Communication and Engagement Plan defines the approach that the Port is taking to ensure that the program is built on a broad range of perspectives and considerations. The plan includes a community engagement meeting series, an interactive website, participation in community events, attendance and presentations at existing community group meetings, a resource and regulatory agency working group, and a variety of media and communications strategies.

1.3.4.6 Citywide Resilience Coordination Team (ongoing)

The CCSF has several departments that are leading resilience work and continuing to collaborate to advance this work. The Office of Capital Planning and Resilience is leading the update to the City's 2014 *Local Hazard Mitigation Plan* (LHMP). The update to the LHMP will include climate hazards and is being renamed the *Hazard and Climate Resilience Plan*. The City Planning Department is leading the *Sea Level Rise Action Plan* and is currently completing the Citywide *Sea Level Rise Vulnerability and Consequences Assessment* for City-owned assets, including the Port's jurisdiction. The San Francisco Department of the Environment is leading the update to the City's *Climate Action Strategy*, which identifies actions the City can take to reduce greenhouse gas emissions. Due to its role in leading several key resilience initiatives and its location along a significant portion of San Francisco's shoreline, the Port has an integral role in the Citywide Resilience Coordination Team and works closely with other departments to ensure that resilience work is aligned and integrated.

1.3.4.7 Port Development Projects

Approximately 10 years ago, the Port Commission directed Port staff to assess new projects for SLR and develop approaches to increase the resilience of projects along the shoreline within the Port's jurisdiction. Projects have included a number of approaches to address future SLR, including raising building sites, and making buildings and spaces more flood resilient with designs that can accommodate temporary flooding. Additionally, many of these development projects include financing mechanisms to provide funding for future adaptation projects. These projects include:

1. *PIER 70* - The Basis of Design Report (see Appendix A) provides specific elevations for infrastructure, open space, and finish floors that range for a SLR allowance between 24" and 66".
2. *MISSION ROCK* - In the Mission Rock development, park and trail land located closest to the waterfront is set at a lower grade, while all occupied spaces are set back and gradually raised 5.5 feet farther inland (meeting end of century forecasts). Sidewalks and loading docks are also elevated to ensure continuing pedestrian access as water levels rise.
3. *CRANE COVE PARK* – This site applies the *Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco*" (CPC Guidance), which was adopted by the Capital Planning Committee (CPC) in 2014. This guidance was developed by a Sea Level Rise Technical Committee appointed by former Mayor Ed Lee as a framework for City agencies to evaluate adaptation considerations into new construction, capital improvement, and maintenance projects.
4. *WATER EMERGENCY TRANSPORTATION AUTHORITY (WETA) FERRY TERMINAL EXPANSION AT THE FERRY BUILDING* – The WETA ferry terminal project was designed to address potential flooding and SLR through onsite stormwater management and design of structures to provide sufficient freeboard above 100-year water levels. The new gates were built at 13 to 13.5 feet above mean lower low water, providing 3.8 to 4.3 feet of freeboard above a 100-year storm, or 2.5 to 3 feet freeboard above a 100-year storm, with anticipated SLR of 16 inches by 2050. Elevations of the new decks will provide at least 1.7 feet of freeboard above the 100-year storm with anticipated SLR.

Development projects and capital planning projects have the benefit of City, regional, and state guidance to provide the most appropriate water levels to plans for based on projected risks and consequences. This guidance includes:

1. State of California Sea Level Rise Guidance 2018 Update (OPC)
2. San Francisco Bay Plan Climate Change Policies (BCDC)

3. Guidance for Incorporating Sea Level Rise Into Capital Planning in San Francisco (CCSF)

2 SEA LEVEL RISE SCENARIOS + MAPS

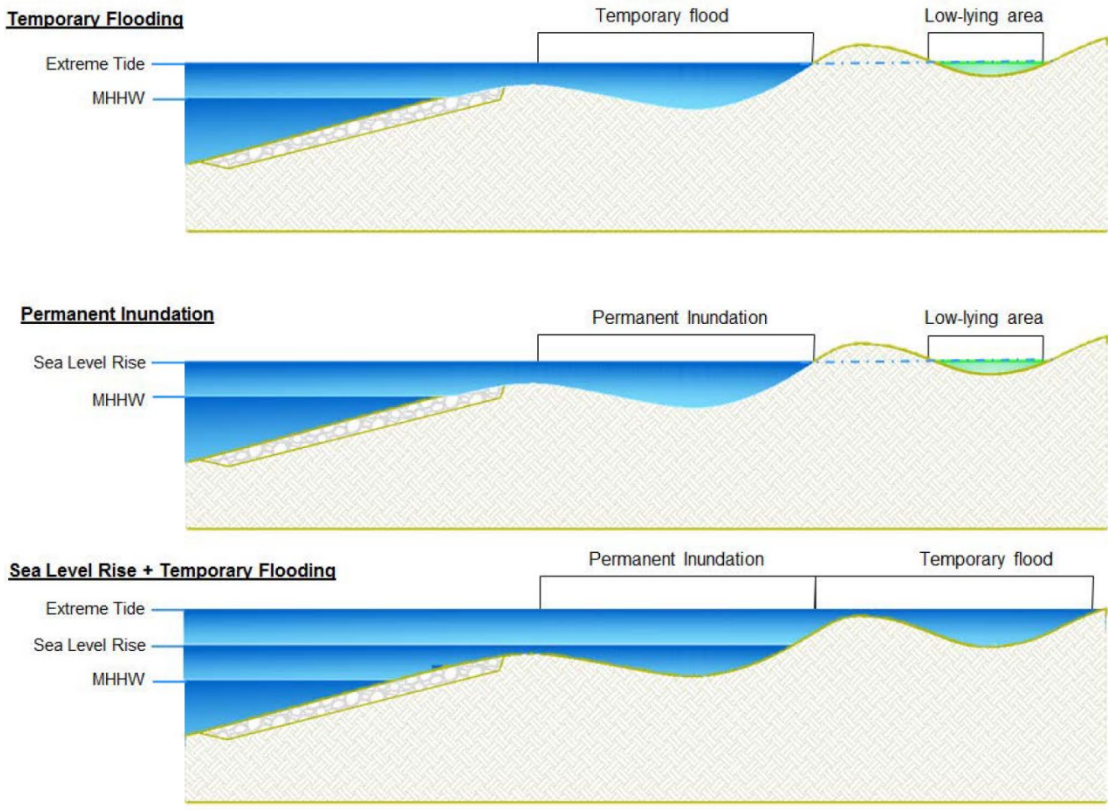
2.1 SLR Projections + Scenarios

The San Francisco waterfront is strongly influenced by minor variations in water level as a result of the shoreline and the Bay's character. Moreover, the climate science around SLR has been evolving in recent years. Selecting the most appropriate SLR scenario to support long range planning and policy, capital planning and project planning should be based on the risks posed by the hazard, the possible timing of the risks, and the consequences of the risks. The San Francisco Bay has several regional models that are used to assess exposure to different water levels and a variety of flooding and SLR scenarios. These models provide the ability for the Port and other City departments to create a series of maps that depict a variety of water levels representing different flooding and SLR scenarios mapped on top of a baseline mean higher high water (MHHW, year 2000 baseline), paired with a specific extreme tide or storm surge interval such as the 1% annual chance storm surge event (i.e., 100-year storm surge event). Scenarios approximate either:

- Permanent inundation scenarios, or
- Temporary flood conditions from specific combinations of SLR and extreme tides.

For example, the water elevation associated with 36 inches of SLR is similar to the water elevation associated with a combination of 24 inches of SLR and a 1-year extreme tide (King Tide). Therefore, a single map can be used to visualize either event. Figure 2-1 shows a representative cross section of a shoreline, illustrating the distinction between permanent inundation and temporary flooding.

Figure 2-1. Shoreline Cross Section - Permanent Inundation and Temporary Flooding



Source: *Port of San Francisco Sea Level Rise Inundation Mapping Technical Memorandum*, AECOM (2016)

This section presents updated SLR projections consistent with the current science and State Guidance, and describes the four 2030, 2050, 2080, and 2100 SLR and storm surge scenarios used in this assessment.

2.1.1 CPC Guidance for Sea Level Rise, CCSF (2014, 2015)

Beginning in 2013, a technical committee was tasked by the Mayor to develop guidance for addressing the City's SLR vulnerabilities. The committee produced a comprehensive summary of SLR science, which informed the development of a *Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco*, adopted Citywide in 2014 and subsequently revised and re-adopted in 2015 (CPC Guidance). The CPC Guidance and the 2016 *Sea Level Rise Action Plan* (see Section 1.3.1) relied on the best available science at the time, the National Research Council's (NRC) 2012 *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present and Future*, which also served as the basis for State guidance. Specifically, the CPC Guidance selected the NRC 2012 SLR projections for the "Likely" and "Upper Range" scenarios as guidance for design and adaptation decisions, respectively, as shown in Table 2-1.

Table 2-1. CPC Guidance for Projected 2030 to 2100 SLR (2014/2015)

2012 NRC Projection	Reference Water Level	Sea Level Rise (inch)
2030 Likely	MHHW + 6-inch	6
2030 Upper Range 2050 Likely	MHHW + 12-inch	12
2050 Upper Range	MHHW + 24-inch	24
2100 Likely	MHHW + 36-inch	36
2100 Upper Range	MHHW + 66-inch	66

Source: *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present and Future*, NRC (2012)

Since 2015, the science around understanding climate change and projected SLR trends and impacts has continued to evolve. In response to updated national and regional studies, the State of California subsequently updated its *Sea-Level Rise Guidance* (State Guidance) in 2018.

2.1.2 State of California Sea Level Rise Guidance, OPC (2018)

The updated State Guidance incorporated probabilistic SLR projections, which associate a likelihood of occurrence with SLR heights and rates, and are directly tied to a range of emissions scenarios, to help decision-makers understand and address potential SLR impacts and consequences. However, probabilistic projections may underestimate the likelihood of extreme SLR resulting from loss of the West Antarctic ice sheet, particularly under high emissions scenarios. Therefore, the updated guidance also included an extreme scenario, referred to as H++. The probability of this scenario remains uncertain and is the focus of ongoing research, and its consideration is important, particularly for high stakes, long-term decisions. Table 2-2 shows these State of California SLR projection ranges for San Francisco through the year 2100.

Table 2-2. State Guidance for Projected 2030 to 2100 SLR (OPC 2018)

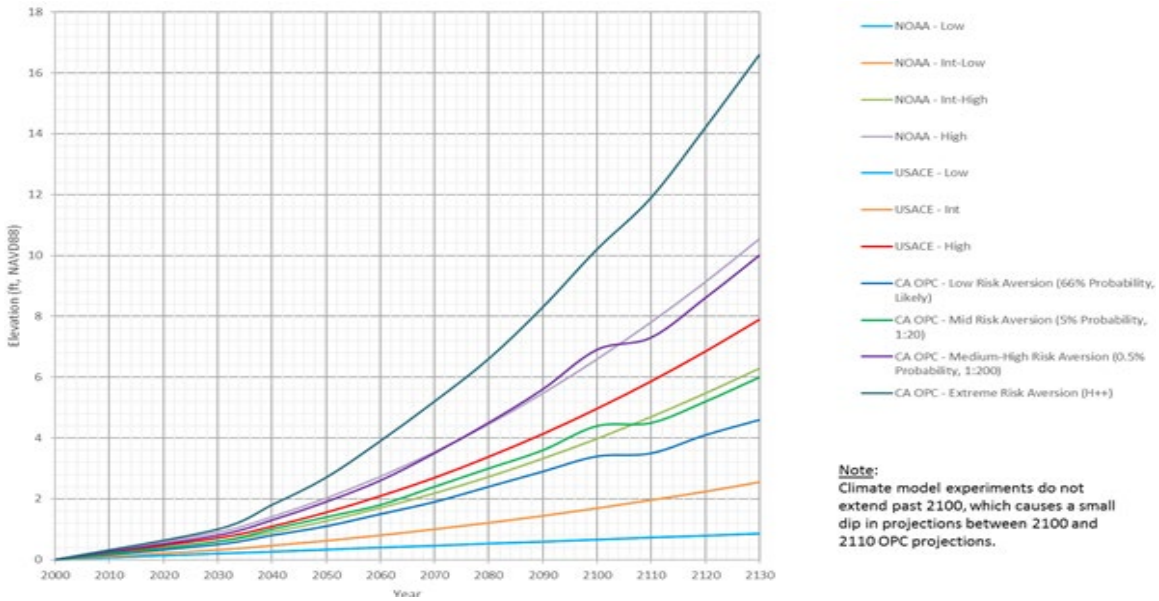
		PROBABILISTIC SLR PROJECTION IN FEET (AND EQUIVALENT INCHES)					
		MEDIAN	LIKELY RANGE		1-IN-20 CHANCE	1-IN-200 CHANCE	
		50% probability SLR meets or exceeds…	66% probability SLR is between…		5% probability SLR meets or exceeds…	0.5% probability SLR meets or exceeds…	H++ scenario (single scenario)
				Low Risk Aversion	Mid Risk Aversion	Medium - High Risk Aversion	Extreme Risk Aversion
High emissions	2030	0.4 (5″)	0.3 (4″)	0.5 (6″)	0.6 (7″)	0.8 (10″)	1 (12″)
	2040	0.6 (7″)	0.5 (6″)	0.8 (10″)	1 (12″)	1.3 (16″)	1.8 (22″)
	2050	0.9 (11″)	0.6 (7″)	1.1 (13″)	1.4 (17″)	1.9 (23″)	2.7 (33″)
Low emissions	2060	1 (12″)	0.6 (7″)	1.3 (16″)	1.6 (19″)	2.4 (29″)	
High emissions	2060	1.1 (13″)	0.8 (10″)	1.5 (18″)	1.8 (22″)	2.6 (31″)	3.9 (47″)
Low emissions	2070	1.1 (13″)	0.8 (10″)	1.5 (18″)	1.9 (23″)	3.1 (37″)	
High emissions	2070	1.4 (17″)	1 (12″)	1.9 (23″)	2.4 (29″)	3.5 (42″)	5.2 (62″)
Low emissions	2080	1.3 (16″)	0.9 (11″)	1.8 (22″)	2.3 (28″)	3.9 (47″)	
High emissions	2080	1.7 (20″)	1.2 (14″)	2.4 (29″)	3 (36″)	4.5 (54″)	6.6 (79″)
Low emissions	2090	1.4 (17″)	1 (12″)	2.1 (25″)	2.8 (34″)	4.7 (56″)	
High emissions	2090	2.1 (25″)	1.4 (17″)	2.9 (35″)	3.6 (43″)	5.6 (67″)	8.3 (100″)
Low emissions	2100	1.6 (19″)	1 (12″)	2.4 (29″)	3.2 (38″)	5.7 (68″)	
High emissions	2100	2.5 (30″)	1.6 (19″)	3.4 (41″)	4.4 (53″)	6.9 (83″)	10.2 (122″)

Source: *State of California Sea Level Rise Guidance*, OPC (2018)

2.1.3 USACE/Port SFWFRS Sea Level Rise Guidance (2018)

As part of the USACE/Port SFWFRS described in Section 1.3.4.2, USACE has its own approved SLR curves that are used in planning efforts. The USACE SLR curves include a low, medium, and high curve. In order to ensure that the SFWFRS work is in compliance with local, regional and State guidance, the Port has requested that USACE include other SLR curves in the SFWFRS and has worked with USACE to compare National Oceanic and Atmospheric Administration (NOAA), State of California, and USACE SLR curves in order to determine the best way to balance between USACE and State of California guidance. A comparison of these curves is shown in Figure 2-2.

Figure 2-2. USACE, NOAA, and OPC 2018 SLR Curves



Source: *Incorporation of Sea Level Change into the Formulation and Evaluation Process for the USACE San Francisco Waterfront Storm Risk Management Study*, Port (2018)

In order to ensure that future projects are consistent with State of California SLR guidance, the Port has recommended that the USACE Flood Study include the State of California Medium-High Risk aversion (i.e.1 in 200) curve and the NOAA Intermediate-High Risk aversion curve which correlates closely with the State of California Mid-Risk aversion curve (i.e. 1 in 20). The 2030, 2050, 2080, and 2100 SLR scenarios recommended for inclusion in the SFWFRS are denoted by red text in Table 2-2.

2.1.4 San Francisco SLR Scenarios

The Port and City recently adopted a range of SLR scenarios that are compatible with both updated CPC and State Guidance, developed using the "One Map, Many Futures" framework. This approach originated from the BCDC's *Adapting to Rising Tides* (ART) program and defines 10 primary scenarios (denoted by shaded cells in the leftmost column of Table 2-3) that represent a range of SLR projections combined with possible extreme tide (also referred to as King Tide) levels from a 1-year to 100-year return frequency. These combinations result in a matrix of over 50 water level outcomes, shown in Table 2-3.

Table 2-3. Sea Level Rise and Extreme Tide Scenario Matrix

Primary SLR Scenario*	Reference Water Level	Daily Tide +SLR (inch)	Water Level Above MHHW When Combined with Extreme Tide (Storm Surge) 1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Existing Conditions	*MHHW*	*0*	**12**	19	23	27	32	**36**	41
(2030 likely**)	MHHW + 6-inch	6	18	25	29	33	38	42	47
Scenario 1 (2030 upper range**) (2050 likely**)	**MHHW + 12-inch**	**12**	**24**	31	35	39	44	**48**	53
	MHHW + 18-inch	18	30	37	41	45	50	54	59
Scenario 2 (2050 upper range**)	**MHHW + 24-inch**	**24**	**36**	43	47	51	56	60	65
	MHHW + 30-inch	30	42	49	53	57	62	**66**	71
Scenario 3 (2100 likely**)	**MHHW + 36-inch**	**36**	**48**	55	59	63	68	72	**77**
	MHHW + 42-inch	42	54	61	65	69	74	78	83
Scenario 4	**MHHW + 48-inch**	**48**	60	67	71	75	80	**84**	89
Scenario 5 *equivalent to 12-inch SLR + 100-year storm surge*	**MHHW + 52-inch**	**52**	64	71	75	79	**84**	88	93
	MHHW + 54-inch	54	**66**	73	**77**	81	86	90	95
	MHHW + 60-inch	60	72	79	83	87	92	**96**	101
Scenario 6 (2100 upper range**)	**MHHW + 66-inch**	**66**	78	85	89	93	98	102	107
Scenario 7 *equivalent to 36-inch SLR + 100-year storm surge*	**MHHW + 77-inch**	**77**	*low likelihood of concurrent extreme events; not considered*						
Scenario 8 *equivalent to 42-inch SLR + 100-year storm surge*	**MHHW + 84-inch**	**84**							
Scenario 9 *equivalent to 54-inch SLR + 100-year storm surge*	**MHHW + 96-inch**	**96**							
Scenario 10 *equivalent to 66-inch SLR + 100-year storm surge*	**MHHW+108-inch**	**108**							

* ± 3-inch tolerance was added to each reference water level to increase the applicable range of the mapped scenarios. For example, Scenario 2 (MHHW +24") is assumed to be representative of all extreme tide/sea level rise combinations that produce a water level in the range of MHHW + 21" to MHHW + 27".

** Per *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present and Future*, NRC (2012)

The water level associated with each of the above 10 primary scenarios can represent multiple equivalent SLR and storm surge combinations. For example, the water level associated with 24" of SLR is analogous to the water level associated with a concurrent 12" SLR and 1-year King Tide event. Therefore, Scenario 2's 24" of SLR can be used to visualize

the extent and depth of inundation associated with both events, which are shaded teal in Table 2-3. Likewise, the other teal-shaded cells represent scenarios that also result in water levels within the ± 3-inch tolerance of 24" of SLR; similarly shaded cells denote scenarios represented by the same inundation condition.

Inundation maps for these scenarios serve as the basis for the CCSF Planning Department's ongoing *Sea Level Rise Vulnerability and Consequences Assessment* (SLRVCA) being conducted as part of the *Sea Level Rise Action Plan* (see Section 1.3.3).

2.2 Maps of 2030, 2050, 2080, and 2100 SLR Scenarios

Inundation maps are a valuable tool for evaluating potential exposure to future SLR and storm surge conditions. Spatial data are analyzed with climate science to estimate when (amount of SLR and/or storm surge) and by how much (depth of inundation) an asset will be exposed. This section presents the latest available inundation maps that have been or are being developed for the City and Port to support the CCSF Planning Department's *SLRVCA*. The definition and selection methodology of SLR scenarios represented by these maps was described in Section 2.1.

Current inundation mapping for the City considers 10 SLR scenarios ranging from 12 to 108 inches, and serves as the basis for the City's ongoing *SLRVCA*. Of these 10 scenarios, this document focuses on the four that correspond to State Guidance Medium-High Risk projection ranges for 2030, 2050, 2080, and 2100, denoted by red text in Table 2-4.

Table 2-4. SLRVCA SLR Scenarios and Equivalent State Guidance

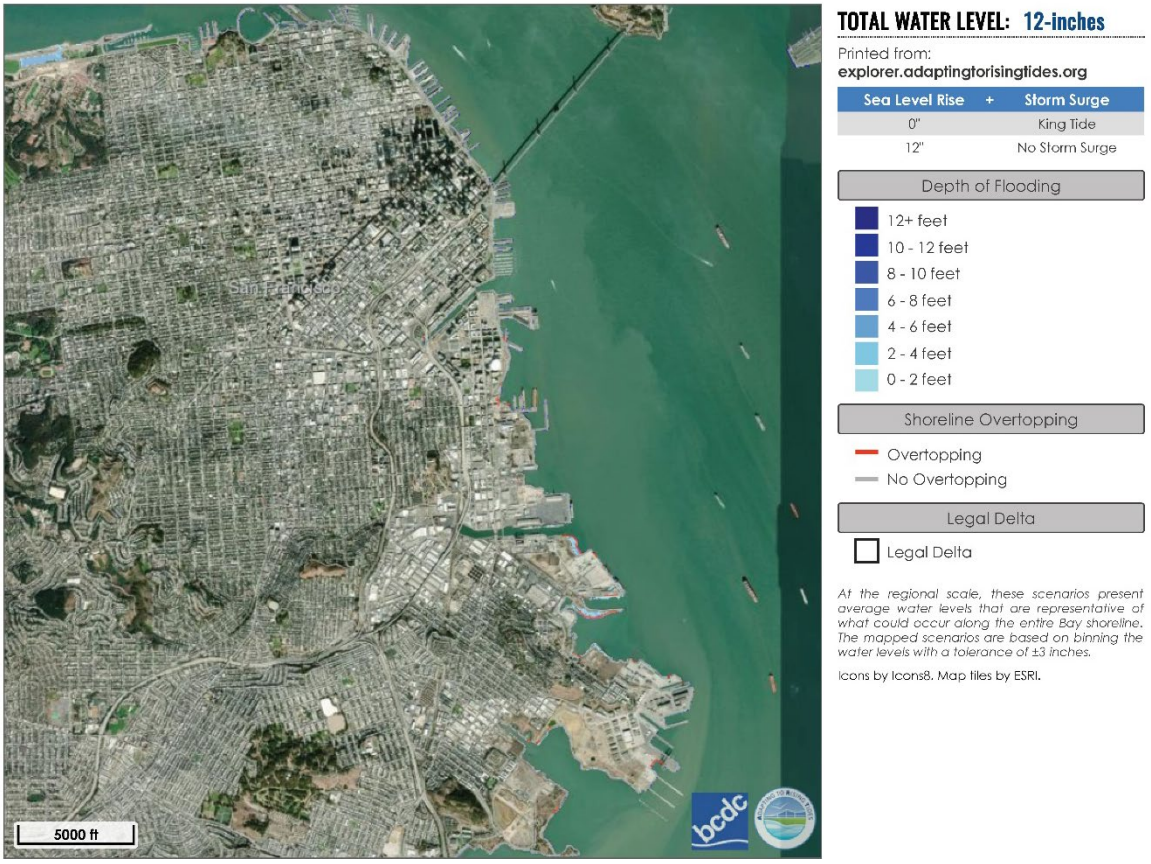
SLRVCA (ongoing)	Equivalent 2018 State Guidance
Scenario 1 MHHW + 12-inch	**2030 med-high risk** MHHW + at least 9.6-inch
Scenario 2 MHHW + 24-inch	**2050 med-high risk** MHHW + at least 22.8-inch
Scenario 3 MHHW + 36-inch	
Scenario 4 MHHW + 48-inch	**2080 med-high risk** MHHW + at least 47-inch
Scenario 5 MHHW + 52-inch	
Scenario 6 MHHW + 66-inch	
Scenario 7 MHHW + 77-inch	
Scenario 8 MHHW + 84-inch	**2100 med-high risk** MHHW + at least 82.8-inch
Scenario 9 MHHW + 96-inch	
Scenario 10 MHHW + 108-inch	

Detailed mapping for all ten scenarios is under development as part of the *SLRVCA*. A subset of preliminary maps showing inundation zones for Port lands under the recommended 2030, 2050, 2080, and 2100 Medium-High Risk scenarios is presented below.

Figure 2-3 represents Scenario 1 with a reference water level of MHHW + 12" SLR and these equivalent combinations (blue cells in Table 2-3):

- 2030 Medium-High Risk
- 2030 upper range SLR + no storm surge
- 2050 likely SLR + no storm surge

Figure 2-3. Projected Inundation Map - Scenario 1: MHHW + 12" SLR

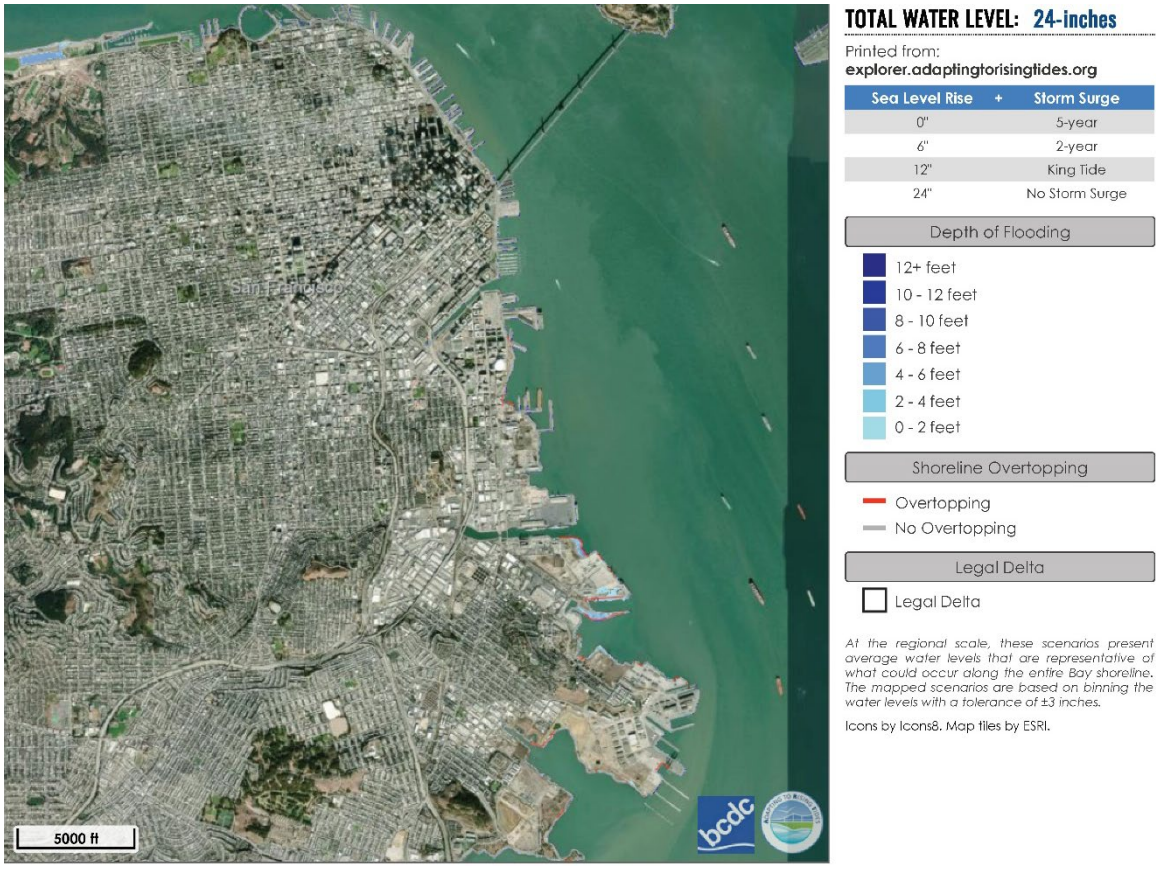


Source: *ART Bay Area*, BCDC (2018)

Figure 2-4 represents Scenario 2 with a reference water level of MHHW + 24" SLR and these equivalent combinations (teal cells in Table 2-3):

- 2050 Medium-High Risk (State Guidance)
- Existing conditions + 10-yr storm surge
- 2030 likely SLR (CPC Guidance) + 2-yr storm surge
- 2030 upper range SLR (CPC Guidance) + 1-yr storm surge
- 2050 likely SLR (CPC Guidance) + 1-yr storm surge
- 2050 upper range SLR (CPC Guidance) + no storm surge

Figure 2-4. Projected Inundation Map - Scenario 2: MHHW + 24" SLR

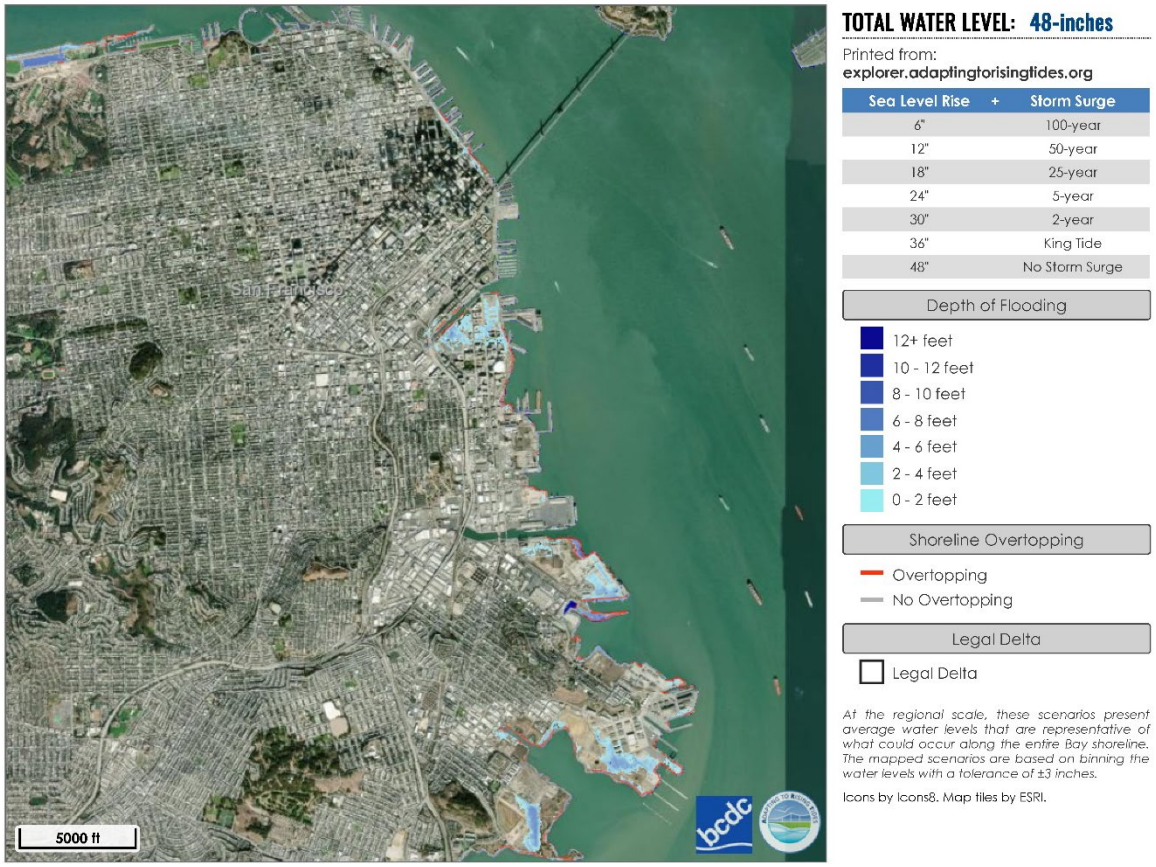


Source: *ART Bay Area*, BCDC (2018)

Figure 2-5 represents Scenario 4 with a reference water level of MHHW + 48" SLR and these equivalent combinations (light green cells in Table 2-3):

- 2080 Medium-High Risk (State Guidance)
- 2030 likely SLR (CPC Guidance) + 100-yr storm surge
- 2030 upper range SLR (CPC Guidance) + 50-yr storm surge
- 2050 likely SLR (CPC Guidance) + 50-yr storm surge
- 2050 upper range SLR (CPC Guidance) + 5-yr storm surge
- 2100 likely SLR (CPC Guidance) + 1-yr storm surge

Figure 2-5. Projected Inundation Map - Scenario 4: MHHW + 48" SLR

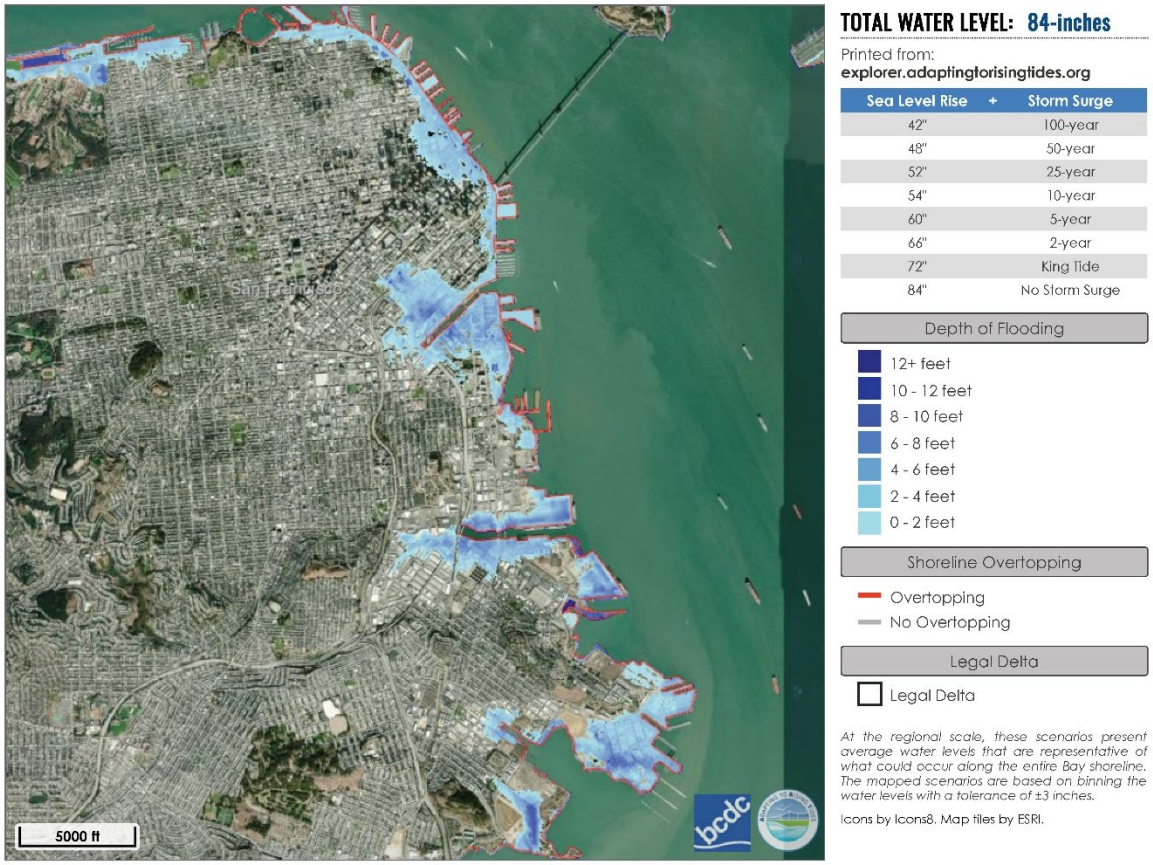


Source: *ART Bay Area*, BCDC (2018)

Figure 2-6 represents Scenario 8 with a reference water level of MHHW + 84" SLR and these equivalent combinations (dark orange cells in Table 2-3):

- 2100 Medium-High Risk (State Guidance)
- 2100 upper range SLR (CPC Guidance) + 2-yr storm surge

Figure 2-6. Projected Inundation Map - Scenario 8: MHHW + 84" SLR



Source: *ART Bay Area*, BCDC (2018)

3 INVENTORY OF VULNERABLE ASSETS + IMPACTS

As a steward for the Public Trust of the State of California, the Port has been incorporating SLR adaptation into its decision-making to promote a vibrant and resilient waterfront. Multiple vulnerability assessments have been developed over the past several years to catalog and prioritize the Port's vulnerable assets. These analyses continue to be refined with evolving SLR science; for example, the Seawall Program has a robust multi-hazard risk assessment that is determining the seismic and flood risk to the assets from Fisherman's Wharf to Mission Creek. A summary of Port vulnerability inventory studies is shown in Table 3-1:

Table 3-1. Port Asset Inventory Studies and Ongoing Efforts

Name, Type, and Date	Key Assets Evaluated	Extent
Sea Level Rise and Adaptation Study [Port, 2012]	Piers, Buildings, Transportation, Utilities	All Port property
Mission Creek Draft Sea Level Rise Adaptation Study [Port, 2015]	Piers, Buildings, Transportation, parks and open space, ecological and environmental resources	Portion of Port property and properties surrounding Mission Creek
Northern Waterfront Seawall Study [Port, 2016]	Shoreline Protection Systems	Portion of Port property
Adapting to Rising Tides Bay Area (ART) [BCDC, ongoing]	Transportation/Transit, Priority Development Areas, Priority Conservation Areas, Communities of Concern and Vulnerable Communities	All assets within the current and future flood zone along San Francisco Bay shoreline
Citywide Resilience Coordination Team [CCSF, ongoing]	All assets and services within the current and future flood zone, including: Piers, Buildings, Transportation, Bulkheads, Related Infrastructure, downtown residential, commercial, etc. buildings, parks and open spaces, historic structures, jobs and wages, ecological and environmental assets	All assets within the current and future flood zone Citywide

Name, Type, and Date	Key Assets Evaluated	Extent
Sea Level Rise Vulnerability and Consequences Assessment (SLRVCA) [CCSF, ongoing]	All assets and services within the current and future flood zone, including: Piers, Wharves, Buildings, Transportation, Bulkheads, Utilities, Parks and open spaces, Adaptation Projects	All assets within the current and future flood zone Citywide
San Francisco Waterfront Flood Resilience Study (SFWFRS) [Port/USACE, ongoing]	Federal interest assets and services within the current and future flood zone, including: Piers, Buildings, Transportation, Bulkheads, Related Infrastructure, downtown residential, commercial, etc. buildings, parks and open spaces, historic structures, jobs and wages, ecological and environmental assets	All assets within the current and future flood zone from Aquatic Park to Heron's Head Park
Islais Creek Adaptation Study [Planning, SFMTA, Port, ongoing]	Transportation, piers and port facilities, small businesses and commercial and PDR, water and wastewater facilities, natural areas, buildings (all assets within the project area with an emphasis on transportation assets)	Islais Creek to Heron's Head in the south and inland to the upper extent of the current and future flood zone
Embarcadero Seawall Program Multi-hazard Risk Assessment [Port, ongoing]	All assets and services within the current and future flood zone, including: Piers, Buildings, Transportation, Bulkheads, Related Infrastructure, downtown residential, commercial, etc. buildings, parks and open spaces, historic structures, jobs and wages, ecological and environmental assets	All assets within the current and future flood zone from Fisherman's Wharf to Mission Creek

Of these efforts, the *SLRVCA* is nearing completion, and represents the most current catalog of Port SLR vulnerabilities; therefore, it is the basis for the inventory of vulnerable Port assets and impacts described in subsequent sections.

3.1 Assessment Approach

The *SLRVCA* process is defined by collaboration, transparency and sustainability. These focal points guide each phase of the assessment process:

- An *asset inventory* collects and categorizes, by service provided, all city-owned infrastructure through both GIS mapping and detailed surveys of all asset-owning departments across the city. It is important to note that PG&E is completing this assessment separately and those findings will be incorporated into the cities approach once they are available.
- Secondly, the *exposure assessment* uses a GIS analysis to determine the risk to the assets in relation to the 10 SLR scenarios. Any asset outside of the SLR Vulnerability Zone is excluded from the *SLRVCA*, except for key safety facilities (e.g. fire station) that fall close to the zone.
- The third step is the *vulnerability assessme*nt, which categorizes assets according to their sensitivity and adaptivity to SLR and flooding.
- Finally, the assets are evaluated through understanding the *consequences* losing the asset to temporary or permanent flooding would have across the four sustainability frames of society and equity, economy, environment and governance. This high-level analysis considers impacts from neighborhood- to regional-scales, with preliminary results publicly shared and expanded on through neighborhood workshops.

3.1.1 SLRVCA Scenarios

Of the 10 scenarios considered in the *SLRVCA*, this document focuses on the four that correspond to State Guidance Medium-High Risk projections for 2030, 2050, 2080, and 2100 described in Section 2 and delineated in Table 2-4.

3.1.2 Impact Assessment Framework

The impact assessment approach uses aspects of sustainability in the four frames of society and equity, economy, environment and governance. This sustainability framework comes out of BCDC's Adapting to Rising Tides (ART) Program.

- *SOCIETY + EQUITY:* The frame of society and equity works to understand the impacts on the community and the services they require. This view also considers how SLR can exacerbate existing inequalities.
- *ECONOMY:* Understanding the direct economic impact of lost assets helps to assign costs to infrastructure replacement. Potential damages must also be evaluated as well as lost revenue throughout the marketplace at the time of the event and during recovery. Physical assets as well as disruption of services must be evaluated to fully understand the economic impacts.

- *ENVIRONMENT:* Environmental values that may be affected include air, water, habitat, natural systems, and ecosystem functions. There is also concern for the exposure of contaminated soils and surface pollutants during flooding events that can have long term consequences.
- *GOVERNANCE:* The Governance framework incorporates institutional factors such as organizational structure, partnerships, and jurisdiction into the understanding of the impacts of key assets on the city.

3.1.3 Asset Categories

The *SLRVCA* evaluates infrastructure located on Port lands within the southern waterfront extending from Mission Creek to India Basin. An inventory and assessment of Port assets north of this area is in progress under the Seawall and SFWFRS studies, anticipated to be complete in 2020. The assets are organized by four categories:

- Port structures
- Recreation and public open space
- Transportation, and
- Utilities

Assets within each category are further differentiated based on Port use and service type. Port structures comprise the main pieces of infrastructure, and include piers and harbors located along or within the water and therefore were determined vulnerable. These waterfront areas include a mix of commercial, maritime, and industrial activities that range in scale from a single pedestrian to a large ferry boat.

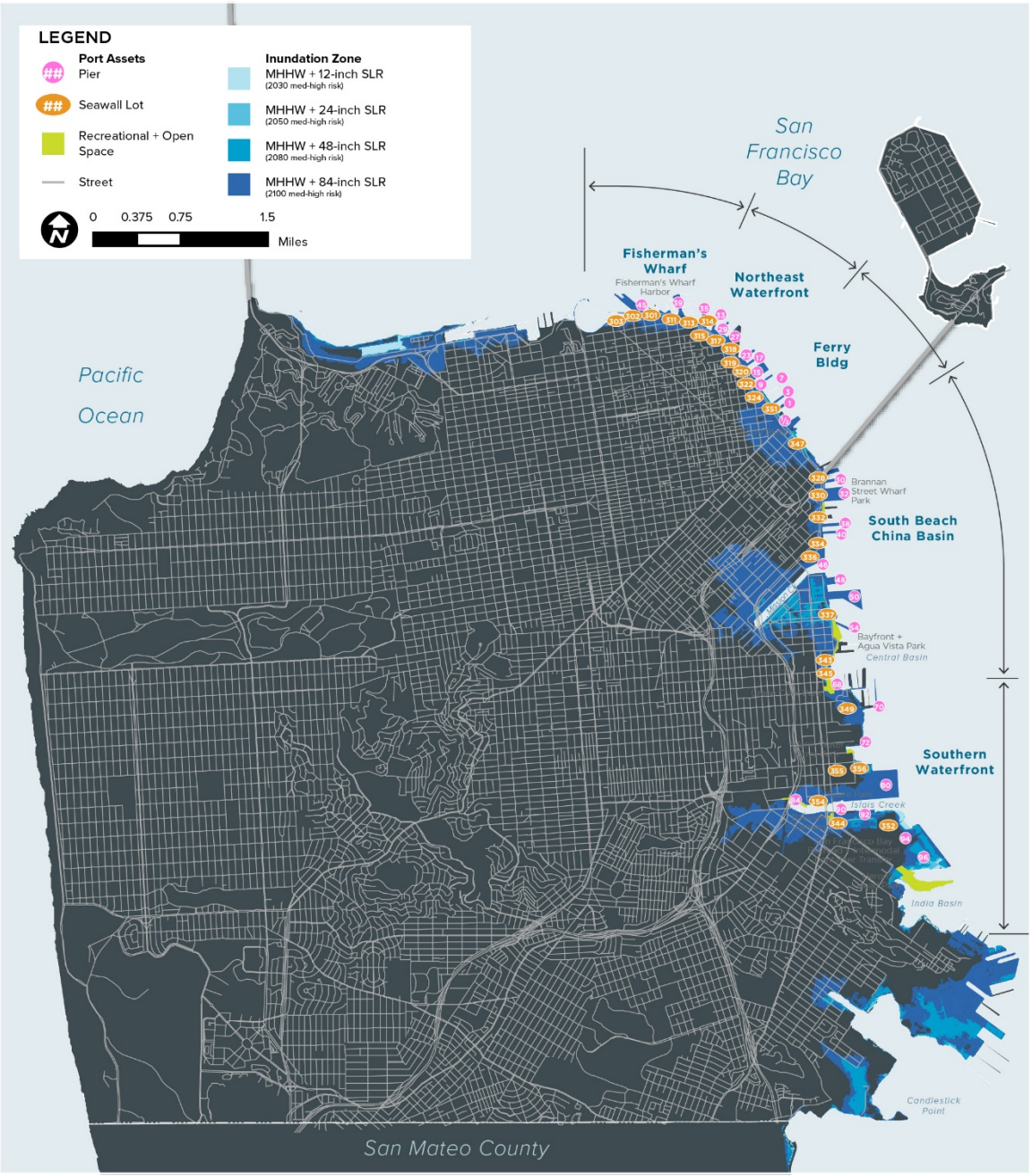
Many of the City's parks and open spaces are located along the shoreline on Port property. These spaces provide recreation, access to the water, and environmental benefits for the area. Due to their proximity to the shoreline, many of these locations already experience flooding and erosion under existing conditions.

A variety of transportation assets are located on Port lands such as rail, bridges, streets, ferry terminals, maritime berths, and parking lots. The Port portion of the SLRVCA focuses on the railroad assets and maritime berths. The San Francisco Bay Railroad provides important industrial services to the City and currently lacks redundancy.

Although the Port has many utilities located beneath the property, the main utility discussed is the Port's storm sewer system. Potable water and wastewater are evaluated within the larger context of the connection to the City. Due to the City's combined sewer system in major parts of the City that drain stormwater to the San Francisco Bay, the Port has developed a Stormwater Management Plan in accordance to the City's requirements. Stormwater sewer systems located under the piers are vulnerable to SLR damage and

eventually will become inaccessible. There are adaptation and relocation plans in place with estimated completion in approximately 30 years, though funding has not yet been secured.

Figure 3-1. Port Assets and Projected SLR Inundation Zones – 2030, 2050, 2080, 2100



3.2 Summary of Vulnerabilities + Consequences

The SLRVCA exposure analysis findings for Port assets are summarized in Table 3-2 for the three Medium-High Risk SLR scenarios for 2030, 2050, 2080, and 2100 SLR planning horizons (see red text in Table 2-4). Exposure is expressed as a percentage of overall asset area impacted by inundation zones associated with each SLR scenario. Port utilities exposure analysis is in progress and is not yet complete.

Table 3-2. Port Asset Exposure with Sea Level Rise (% Inundated)

	CCSF SLRVCA Scenario	Scenario 1 (MHHW + 12-inch)	Scenario 2 (MHHW + 24-inch)	Scenario 4 (MHHW + 48-inch)	Scenario 8 (MHHW + 84-inch)
	Equivalent State Guidance	*2030 med-high risk*	*2050 med-high risk*	*2080 med-high risk*	*2100 med-high risk*
Piers + Harbors	Pier 48	0%	0%	0%	100%
	Pier 50	0%	0%	0%	100%
	Pier 50 1/2	3%	7%	32%	87%
	Pier 52	0%	0%	0%	100%
	Pier 54	0%	0%	0%	99%
	Pier 62	3%	8%	24%	83%
	Pier 68	1%	2%	7%	82%
	Pier 70	0%	0%	0%	85%
	Pier 80	0%	0%	1%	95%
	Pier 90	0%	0%	1%	86%
	Pier 92	0%	0%	18%	97%
	Pier 94	0%	0%	17%	59%
	Pier 96	3%	16%	55%	88%
	Mission Creek Harbor	1%	1%	1%	2%
Seawall Lots	Seawall Lot 337	0%	0%	54%	100%
	Seawall Lot 343	0%	0%	0%	100%
	Seawall Lot 345	6%	20%	49%	94%
	Seawall Lot 349	0%	1%	2%	53%
	Seawall Lot 3491	0%	0%	0%	100%
	Seawall Lot 349	0%	0%	0%	52%
	Seawall Lot 356	0%	0%	0%	37%
	Seawall Lot 356	0%	1%	9%	44%
	Seawall Lot 344-East	0%	0%	15%	58%
	Seawall Lot 344-West	0%	0%	0%	100%
	Seawall Lot 352	8%	9%	13%	22%
	Seawall Lot 354	0%	0%	0%	93%

	CCSF SLRVCA Scenario	Scenario 1 (MHHW + 12-inch)	Scenario 2 (MHHW + 24-inch)	Scenario 4 (MHHW + 48-inch)	Scenario 8 (MHHW + 84-inch)
	Equivalent State Guidance	*2030 med-high risk*	*2050 med-high risk*	*2080 med-high risk*	*2100 med-high risk*
Recreation + Open Space	China Basin Park	4%	8%	19%	86%
	Mission Creek Shoreline South	2%	4%	40%	91%
	Mission Creek Shoreline Garden	0%	0%	4%	100%
	Pier 52 Boat Launch	4%	10%	39%	80%
	Bayfront Park	4%	7%	23%	88%
	Agua Vista Park	3%	7%	16%	81%
	Agua Vista Park Pier	0%	0%	0%	0%
	Warm Water Cove Park	2%	5%	10%	21%
	Islais Creek North (PUC Promenade)	0%	0%	0%	69%
	Islais Creek North (MTA Promenade)	0%	0%	0%	100%
	Tulare Park	0%	0%	0%	92%
	Islais Creek South (Islais Landing)	0%	0%	0%	96%
	Bayview Gateway	0%	0%	0%	96%
	Pier 94 Wetlands	49%	54%	62%	81%
	Heron's Head Park	3%	16%	55%	88%
	Heron's Head Extension	0%	0%	0%	9%
Port Transportation	San Francisco Bay Railroad	0%	6%	14%	69%
	Intermodal Container Transfer Facility	0%	0%	10%	28%

Source: *Sea Level Rise Vulnerability and Consequence Assessment*, CCSF (ongoing)

Based on the level of exposure, assets were then evaluated in terms of vulnerabilities and consequences.

- *PORT STRUCTURES*: Over 55% of the piers begin to flood at SLR Scenario 4 and although the structures can recover from temporary flooding, damage can occur, and the use of space is disrupted. Any permanent flooding would require adaptation or abandonment of the asset. Specific piers have essential infrastructure that would have impacts beyond the location such as the City's recycling facility or major San Francisco Bay Railroad connections. As flooding becomes more frequent and widespread, access to some facilities, particularly sub-

structures, may grow more unreliable, maintenance and operations costs would increase, as would costs of disruption and physical damage.

- *RECREATION AND PUBLIC OPEN SPACE*: Some locations will experience extreme flooding at Scenario 1. Most of the parks and open spaces are considered highly sensitive to flooding, with minimal redundancy for these spaces in the City. Wildlife habitat would be impacted significantly with little ability to adapt these places to permanent inundation.
- *TRANSPORTATION*: Rail cannot operate with even minimal flooding and most operations become impacted at SLR Scenario 2. The maritime berths provide many types of services and although vessels themselves will not be impacted by flooding, access to the vessels will be. Damage caused by flooding is also a concern. Consequences of concern include potential impacts to the local economy, increase in traffic due to limited transportation options, and exposing contaminated soil.
- *UTILITIES*: Generally, assets located under piers are more vulnerable to SLR. These utilities run underneath the pier decks where they are constantly exposed to harsh conditions from corrosive Bay waters and impacts from debris mobilized by waves and tidal forces. These utilities have high corrosion rates and will eventually become inaccessible for maintenance and replacement as sea levels rise. Sump pumps are also located below the pier decks and are subject to saltwater intrusion and corrosion. On land, utilities will experience fewer disruptions and will likely be able to handle temporary flooding. However, if saltwater enters the storm sewer system through sump pumps or storm drains, it could corrode the pipes increasing their sensitivity to SLR.

4 FINANCIAL COSTS OF SLR

This section summarizes completed and on-going analyses of costs related to SLR impacts to Port assets.

4.1 Past Financial Cost Analyses

To help inform preliminary decision-making around prioritizing critical seawall improvements, the Port completed high-level preliminary estimates in 2017 to assess the economic value at-risk from a seawall breach resulting from a natural disaster, including SLR scenarios. These initial estimates showed significant variation; some very preliminary findings suggest direct SLR impacts to Port facilities could reach $9.1 billion[1] for a total water level of MHHW + 66 inches (Scenario 6). With recent advances in climate change science now available, a comprehensive reexamination of projected cost impacts is now underway as the Port and City continue bolstering its adaptation strategies.

4.2 Current Financial Cost Analyses

Financial cost impacts for the Port are being re-evaluated based on updated SLR scenario models in development under the ongoing Seawall and SFWFRS studies, scheduled for completion in 2020. Once completed, these refined and comprehensive cost analyses will help to inform the Port's SLR adaptation strategies and priorities.

[1] Port of San Francisco Economic Value At-Risk Analysis, BAE (2017)

5 SLR MITIGATION + ADAPTATION MEASURES

5.1 Completed + Planned Projects

In addition to the Port's Waterfront Resilience Program described in Section 1.3.4, the City and Port's SLR resilience will also be bolstered by other projects and initiatives, listed below.

5.1.1 Southeast Framework

The Southeast Framework is a partnership between the Planning Department and the Office of Economic and Workforce Development and Capital Planning. Developments within the Southeast area include SLR adaptation onsite, and several developments contribute to Port-wide resilience funds to further support climate change resiliency.

5.1.2 Pier 70 Development

This proposed development in the Central Waterfront District will adapt to SLR through grade changes, floodable open space along the shoreline, and building elevation as necessary. The project will also contribute to a Port-wide resilience fund.

5.1.3 Potrero Power Station

The Potrero Power Station is a 28-acre site located in the Central Waterfront District east of the Dogpatch neighborhood, directly fronting San Francisco Bay. The overall vision for the Potrero Power Station—along with the Pier 70 site just to the north— is to be a key element in the ongoing transformation of the Central Waterfront into a neighborhood that provides thousands of new homes and jobs, community-serving retail and services, new space for light industrial businesses, a hotel, several acres of new parks, community facilities, and unprecedented waterfront access. The proposed development will adapt to SLR by grading, elevating its waterfront riprap and seawall, and designing floodable shoreline open space.

5.1.4 India Basin

India Basin is located in the Southern Waterfront District, generally between the PG&E Power Plant site and Hunters Point Shipyard. The India Basin Waterfront Parks and Trails Project would create a new 1.8-acre public park at 900 Innes and rehabilitate two existing open spaces, India Basin Shoreline Park (5.6 acres) and India Basin Open Space. The proposed development will adapt to SLR by grading, elevating its waterfront rip rap and seawall, and designing floodable shoreline open space.

5.2 Additional Adaptation Measures + Next Steps

In recognition of the critical need to increase the resilience of the Port's assets and services and reduce the urgent seismic safety and increasing flood risk along the Port's 7 ½ mile jurisdiction, the Port created the Waterfront Resilience Program (see Section 1.3.4). The Waterfront Resilience Program is made up of several large initiatives (Embarcadero Seawall

Program and the USACE Flood Resilience Study), some smaller, focused projects (Floodproofing the Piers, Southern Waterfront Seismic Vulnerability Assessment), supports work being led by other Port divisions (Planning and Environment, Real Estate, Engineering, Maritime, Operations and Maintenance, Finance, etc.) and participates in City (Sea Level Rise Action Plan, Sea Level Rise Vulnerability and Consequences Assessment, Hazard and Climate Resilience Plan, Lifelines, Extreme Precipitation Study, Islas Creek Adaptation Project) and regional (Bay CAN, Adapting to Rising Tides, Bay Area Regional Collaborative, Plan Bay Area, etc.) resilience efforts.

In addition to creating the Waterfront Resilience Program, the Port has been engaged in developing the elements of the program, including:

- an adaptive planning framework;
- vision, principles, and goals;
- evaluation criteria and decision-making process; and
- a thorough assessment of seismic and flood risk for all Port assets and services within the hazard zones.

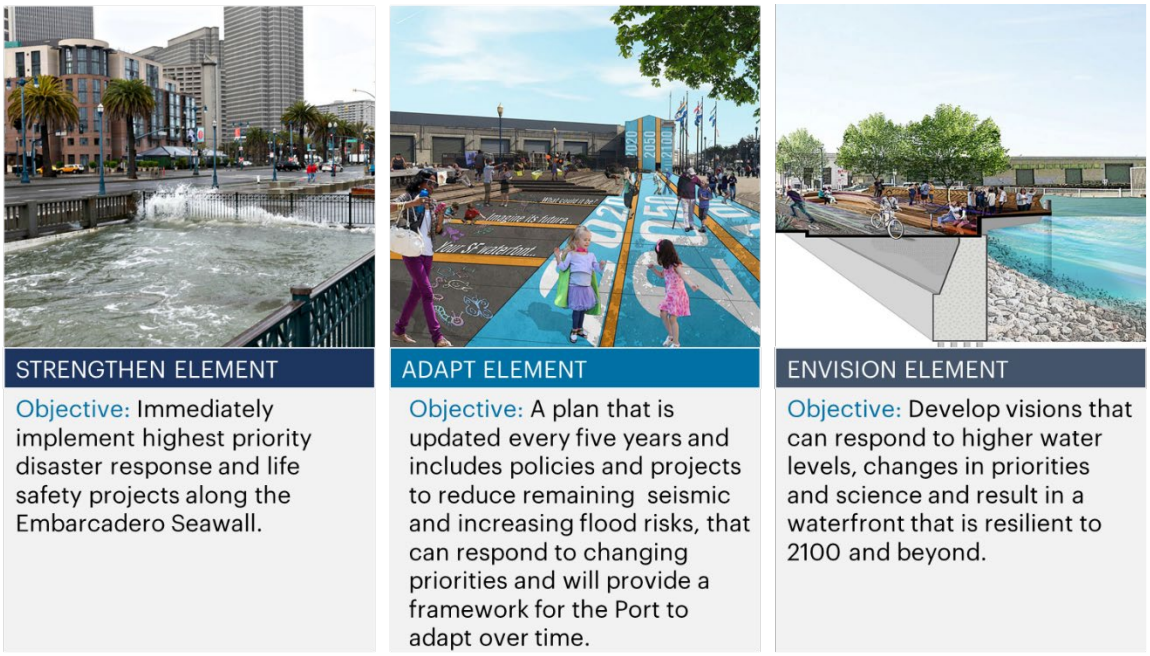
The adaptive planning framework allows the Port to act now to address risks to life safety and emergency response, while adapting over time to address additional seismic and increasing flood risk to envision a future San Francisco Waterfront that is resilient to conditions projected for 2100 and beyond. The framework is also designed to allow the Port to be responsive to community priorities, changes in science, and funding and partnership opportunities. The framework includes three elements, summarized below and in Figure 5-1.

- *STRENGTHEN PROJECTS:* Immediately implement highest priority disaster response and life safety projects.
- *ADAPT PLAN*: Identify policies and projects that will result in a Port that is resilient to remaining seismic risk and increasing flood risk and respond to changes in priorities and opportunities, including changes in science (projections and best practices related to seismic and flood risk), changes in community priorities and new opportunities (projects being advanced by others in the risk zone, new funding or partnership opportunities, etc.). The Adapt Plan will be updated every five years to reflect any changes and to advance new actions and recommendations to be prioritized for implementation by the Port and the city. The first Adapt Plan will advance at least three actions:
    1. The initial Strengthen Projects
    2. The USACE SFWFRS Tentatively Selected Plan (TSP)

3. Any actions identified from the Envision Process with broad support and consensus that near-term implementation is advantageous.

- *ENVISION PROCESS*: The Envision Process is designed to result in a waterfront that is resilient to conditions projected for 2100 and beyond. Envision will include three to five scenarios to address future flood risks and will assess a range of water levels. Envision will include visions that can respond to seismic conditions of the shoreline, increasing flood risks, and long-term SLR that will require large, landscape-scale approaches to reduce risk. While Envision is designed to respond to future conditions, it is possible that some of the concepts and scenarios that are identified have broad immediate support and would therefore be beneficial to advance in the near-term. Additionally, Envision will allow the Port, City, and region to determine how the first Strengthen Projects build toward future visions and how best to adapt the waterfront over time.

Figure 5-1. Waterfront Resilience Framework



Source: Waterfront Resilience Program, Port (2019)

The Port's Waterfront Resilience Program will continue to closely coordinate with other City department and regional partners to ensure alignment with Citywide and regional guidance, policies, projects, and other efforts, leading to a San Francisco that is prepared to adapt to the uncertainties of future sea level rise.

APPENDIX A REFERENCES

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